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SOME FEATURES OF ORNAMENTATION IN FRESH-WATER FISHES

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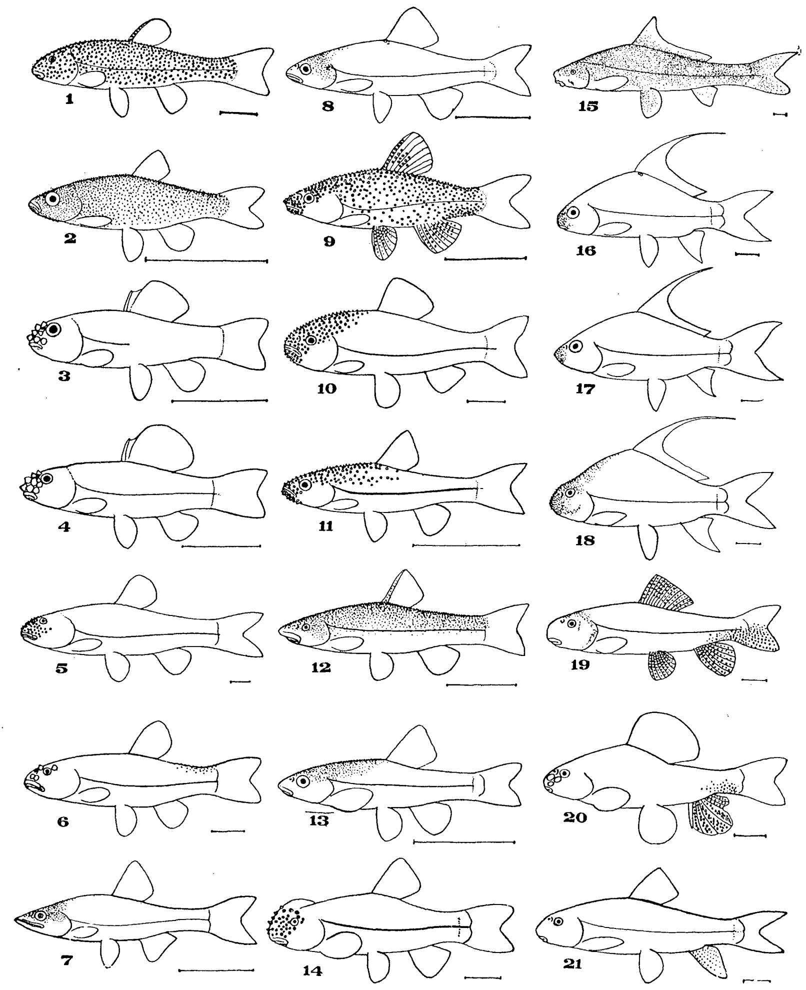
THE fishes known as the minnows (*Cyprinidæ*) and suckers (*Catostomidæ*) are familiar types to almost everybody. Certain of them during the spawning-season exhibit peculiar dermal excrescences or tubercles, these often rendering their appearance quite striking if contrasted with that of other seasons. These tubercles have long been known in many forms, though they do not seem to have been elaborately studied in connection with the relationships of the various groups in which they appear. Considerable difficulty may be encountered by those wishing to make studies of them, not only as they are seasonal and the fishes often difficult to secure at the required time, but also as they crumble and rub or drop off in alcoholic preparations, sometimes not even leaving the usual scars. It is hardly possible to arrange the distribution of the tubercles into distinctive groups of significance. Perhaps when enlarged and few in number on the head they contrast strongly with other cases, such as when very numerous and universally distributed. It may also be added that in a great many of the fishes belonging to the families under consideration no tubercles appear at any season, and this is often generic as well as specific.

As now understood the minnows embrace the largest family in ichthyology, having about 210 genera and 1,500 species in North America, Europe, Asia and Africa. They are mostly fishes of great similarity, small in size, weak, and among the most difficult in which to distinguish species. In this respect our local forms are very frequently no exception. Passing over the different genera



EXPLANATION OF PLATE

The figures are merely outlines, showing the distribution of the tubercles. All are drawn with the accompaning line representing an inch.

1. *Campostoma anomalum.*
2. *Chrosomus erythrogaster.*
3. *Pimephales promelas.*
4. *Pimephales notatus.*
5. *Semotilus bullaris.*
6. *Semotilus atromaculatus.*
7. *Leuciscus elongatus.*
8. *Leuciscus vandoisulus.*
9. *Notropis whipplii analostanus.*
10. *Notropis cornutus.*
11. *Notropis chalybæus.*
12. *Rhinichthys cataractæ.*
13. *Rhinichthys atronasus.*
14. *Hybopsis kentuckiensis.*
15. *Cycleptus elongatus.*
16. *Carpiodes difformis.*
17. *Carpiodes velifer.*
18. *Carpiodes cutisanserinus.*
19. *Catostomus commersonnii.*
20. *Erimyzon sucetta oblongus.*
21. *Moxostoma macrolepidotum.*

and species from the Middle States region it has been my opportunity to study in the present connection, the following conditions are found.

The stone roller (*Campostoma anomalum*) occurs in the Mississippi Valley. In spring or early summer the adult males sometimes have the entire upper surface of the head and body covered with small tubercles, though on the fins I have only found them extending on the rudimentary dorsal rays. Though mostly attended with high coloration, red being more or less conspicuous at most of the bases of the fins, this is not always the case. Others were found full of spawn, without tubercles, but in high color.

The red-bellied dace (*Chrosomus erythrogaster*) is one of the most brilliant of all our common freshwater fishes, occurring mostly west of the Alleghanies. The adult spawning male has the entire head and body almost everywhere covered with minute tubercles in the greatest profusion. No females with tubercles have been secured.

The fat-heads (*Pimephales promelas* and *P. notatus*) are remarkable for their black heads, in the case of spring males, besides having only a few large conspicuous tubercles on the muzzle. The former species occurs only west of the Alleghanies while the latter is found in all the river-basins of Pennsylvania. The tuberculate males seem to be the exception, or of short duration in that condition, as among hundreds of examples of the latter but few were found.

The fall fish (*Semotilus bullaris*) and creek chub (*S. atromaculatus*) are two well-known fishes. The former occurs only east of the Alleghanies, and the fully adult male is with brilliant rosy sides and mostly rosy fins. Though reaching a length of nearly two feet, examples three inches long have been taken with fully developed eggs. The only tuberculated examples were all over a foot in length, and had only their muzzles densely covered with small tubercles. No nests were ever found made by the small fish of three or four inches in length.

The nests discovered were attended only by large fish. The creek chub occurs in most all our mountain brooks, and reaches a maximum length of ten inches, though males five inches long have tubercles. These tubercles are few, but quite conspicuous, and occur usually as a pair over each eye and one in front of the latter. Large examples have the scales on the hind part of the back thickened, or but slightly tuberculated. No tuberculated females of either species were secured.

The true dace (*Leuciscus elongatus* and *L. vandoisulus*) are represented by the former in streams west of the Alleghanies and by the latter in streams east of the Alleghanies. In both species the spring males have crimson sides and the top of the head minutely, but inconspicuously, tuberculate. In the eastern species occasionally a female will be found with tubercles on its head above, and also similar brilliant coloration to that of the male.

A few species of shiners (*Notropis*) present cases of tuberculated males. The silver fin (*N. whipplii analostanus*) of our eastern streams has the body and basal portions of the fin-rays largely covered with small tubercles in the adult male. The adult female is occasionally tuberculate. The red fin (*N. cornutus*), found in almost all of our streams, has the adult male very gaudy in spring, its tubercles appearing very conspicuously on the muzzle, front and predorsal region. Occasionally a tuberculate female is found. In the iron-colored shiner (*N. chalybæus*), often brilliant in the spring, the males sometimes have the muzzle, front and predorsal with many rather large tubercles. No females with tubercles were found.

The male of the long-nosed dace (*Rhinichthys cataractæ*) when fully adult has its snout, top of head, entire back and rudimentary dorsal rays minutely tuberculate in the spring. The adult male of the black-nosed dace (*R. atronasus*), one of our most abundant fishes, has the front and predorsal region minutely tuberculate in spring and early summer. No tuberculate females of either species have been found.

The crested chub (*Hybopsis kentuckiensis*) is remarkable for the adipose-like frontal crest of the adult male in the spring, somewhat suggestive of the hooded seal. This species reaches ten inches in length, and examples half that size were taken with tuberculate muzzles, though without the crest.

The suckers are represented by 14 genera and about 77 species, mostly in North America, though several occur in eastern Asia. The following notes will show the conditions in those I have examined.

The carp-suckers (*Carpiodes*) occur in our waters mostly west of the Alleghanies. In several species (*C. difformis, C. velifer* and *C. cutisanserinus*) all have tuberculated muzzles or snouts in the spring males. In fact the last of these was so named by Cope for the fanciful resemblance of this very character to "goose-flesh."

The black horse (*Cycleptus elongatus*) has the body finely tuberculated over its entire upper surface in the spring. The upper surfaces of the paired fins are also tuberculated. Only large or old examples were examined.

Our common fine-scaled sucker (*Catostomus commersonnii*) is the only one of its genus east of the Alleghanies I have found tuberculate. It occurs all over our Middle Atlantic States. The tubercles appear within a very great range of age. Examples three inches long were found with well developed milt and roe, like those nearly two feet in length. The smallest examples with tubercles, which were only on the lower caudal peduncle surface, lower caudal lobe and anal fin, were four inches long. Others, nearly of the maximum size attained by the species, were found with exactly the same arrangement of the tubercles. Examples with the entire upper surface of the body and head, besides the dorsal and paired fins tuberculated, were always over a foot in length, though seldom more. Further, I have every reason to believe these small fish were also spawning with the large ones, as I captured specimens of similar disparity in the same waters in the spawning-season. That many males spawn without ornamentation also appears likely. No tuberculated females were found.

The chub sucker (*Erimyzon sucetta oblongus*) has quite pronounced sexual differences, the spring males showing usually three large tubercles on each side of the snout, the anal rays tuberculated, and usually the last rays more or less incised. These characters only appear in males over five inches, and until the maximum size (eleven inches) is obtained.

The red horse (*Moxostoma*), with its numerous species, often exhibits the anal fin tuberculated (*M. macrolepidotum*). I have not obtained recent material, however, for these studies.

In conclusion the following may be stated.

First. The disposition of the tubercles in the ornamentation of breeding males is not always complete in the known design sometimes attained by certain individuals.

Second. The development of the tubercles may obtain in comparatively small or young individuals provided they are sexually mature. Tubercles occur, so far as I have observed, in the very young, especially in those species which undergo considerable transformation in certain apparent generalized characters, such as the development of the lateral line, change in coloration from a banded or spotted color-pattern to a more uniform tint, etc.

Third. The tubercles are subject to individual characteristics in being retained or lost for a greater or shorter period after the spawning season.

Fourth. The adult male alone in most species exhibits the tubercles, and though occasionally also present in the female of some species the latter seldom assumes equal development in other respects, such as bright pigment, etc.

Fifth. Sexually mature fishes spawn without the tubercles appearing, and in some cases frequently.

Sixth. The effect of different waters, like those of the sluggish warm lowland cedar-swamps where dark and blackish, as contrasted with clear cold rapid upland streams, does not seem to materially change the degree of development.

Seventh. Many species have the inner pectoral rays furnished with tubercles, and these no doubt are of assistance to the males in clasping the females during the spawning operations.[1]

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[1] For the spawning in detail of some species see Reighard, in *Science,* XVII, April 3, 1903, p. 531, and Bull. Bur. Fisheries, XXVIII, 1908, pp. 1111–1136, Pls. 94–120.